

ULTRA LOW POWER, RADIATION TOLERANT UHF RADIO TECHNOLOGIES FOR IN SITU COMMUNICATION APPLICATIONS. N. E. Lay, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, e-mail: norman.e.lay@jpl.nasa.gov.

Introduction: For future deep space missions, significant reductions in the mass and power requirements for short-range telecommunication systems will be critical in enabling a wide variety of new mission concepts. These possibilities include penetrators, gliders, miniature rovers and sensor networks. Under joint funding from NASA's Cross Enterprise and JPL's Telecommunications and Mission technology programs, recent development activity has focused on the design of ultra low mass and power transceiver systems and subsystems suitable for operation in a flight environment. For these efforts, the functionality of the transceiver has been targeted towards a specific Mars communications scenario. However, as depicted in Figure 1, the overall architecture is well suited to any short or medium range application where a remote probe will aperiodically communicate with a base station, possibly an orbiter, for the eventual purpose of relaying science information back to Earth. In 2001, these sponsors have been augmented with collaborative expertise and funding from JPL's Center for Integrated Space Microsystems in order to migrate existing concepts and designs to a System on a Chip (SOAC) solution.

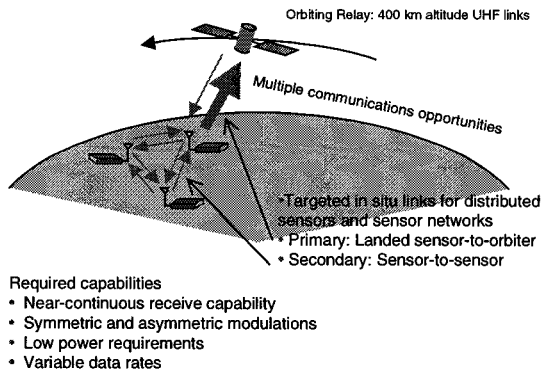


Figure 1. In Situ Communications Scenario

Communications Link, Functionality and Design

Goals: As previously mentioned, the nominal communications link is based on Martian surface-to-orbiter communications for 400 and 800 km altitude orbits. Link analyses indicate that even at slant ranges amounting to nearly twice the orbit altitude (low horizon), substantial margins exist for low data rate (less than 1000 bps) command downlinks utilizing simple uncoded modulations. This in turn can reduce the complexity of the surface probe's receiver and allow for design approaches that tradeoff communications performance against power consumption to aid in mis-

sion longevity. The higher rate uplink, used for science data return, will employ a different, power efficient modulation and coding scheme and it is expected that the transmitter power consumption will be dominated by the power amplifier requirements. This results in a basic functionality consisting of a commandable, uplink communications transmitter. In terms of design goals, this transceiver development is aimed at achieving a better than ten times improvement in receiver power consumption as compared to other recent, short-range communications subsystems.

Current Status and Future Activity: To date, systems analysis has been performed to drive baseline functional specifications for the transceiver. Receiver and transmitter developments have proceeded in parallel with the low power receiver representing the greater developmental challenge. A multi-rate FSK baseband receiver ASIC (Figure 2) has been designed and fabricated by UCLA on a commercial CMOS process [1]. A prototype RF front end has also been developed utilizing discrete components to test the receiver performance. While the ASIC requires less than 2 mW for operation, the discrete front end consumes far more than the design goal. Consequently, the next stage of development will be directed towards RF integrated circuit (RFIC) design targeting a radiation tolerant or hardened process, such as Honeywell's Silicon-on-Insulator CMOS (SOIC). These designs will be captured both as prototype ASICs and as IP (intellectual property – reusable IC designs) for ultimate integration within any SOAC applications requiring telecom. Further evolution of this work will gradually integrate RF and digital IC designs onto a single ASIC and also merge transmitter and receiver functions. The development of these designs will be performed in a modular fashion to ultimately provide a reservoir of rapidly infusible functions tailored to future short-range communications needs.

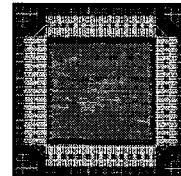


Figure 2. UCLA Ultra Low Power, Digital Baseband, FSK Receiver ASIC (0.25 μ m CMOS)

References: [1] E. Grayver and B. Daneshrad (2000) "A Low Power All Digital FSK Receiver for Space Applications", submitted for publication 2000.